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Study of Various Image Fusion Techniques for the Enhancement of Digital Images

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***Abstract*—**Image fusion is process which is applied to combine two distorted images in order to obtain a single meaningful image. Image fusion is done by extracting some important features from more than one image. Then these extracted features are merged to a single image which is fused image. The fused image has more enhanced quality in comparison to the input images. The image fusion is done by using specific techniques. Some of the techniques are discussed in this work. Image fusion attracts number of researchers to this domain. This work also provides an overview to the work that had been done in past by various authors. This is a guide to the scholars who are working in this domain.

***Index Terms*—** *Image Fusion, Image Enhancements, Transform Domain, Spatial Domain, Frequency Domain.*

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I. INTRODUCTION

With the advancement in the technology each and every field is modulated to digitalization. Hence the number of increased users leads to the induction in problems and errors in technology. Hence image fusion is a solution to one of these problems. The purpose of image fusion is to retain the enrich part of the image. The meaningful information of the image can be maintained by combining the multiple images. There are no constraints or limitations on domain of the input images. The input image can be related to multi focus, multi sensor or other domains. The image below defines the example of image fusion. As there are two images which are not clearly visible one is blurred from right angle and other is blurred from left angle.

Image fusion is a technique which generates a more enhanced image by combining two or more than two images into a single. This is done for achieving more enhanced or meaningful image so that the fused image can lead to effective decision making in near future. Generally the definition of image fusion is to combine two or more than two images in order to produce a single image. The need of image fusion arises when we have more than two images and all of them lack somewhere hence storing all of such images will consume large memory space and almost all of the images does not contain the relevant information individually. At last the solution to this problem is developed in the form of image fusion. The process of image fusion starts by introducing two images as input and then by implementing suitable fusion technique these input images are derived to a single image which contains all of the meaningful content of the image that was original. The image fusion solves the problem of memory area consumption in excess and incomplete meaningless images.

II. TECHNIQUES

Image fusion techniques are used for enhancing the quality of any digital images without ruining its features. The image fusion or enhancement methods are divided in two forms as below:

1. Spatial Domain
2. Frequency Domain

Spatial domain techniques are meant to deal with the pixels in an image. In this the pixel values are altered to perform the enhancements in the image. The following image fusion techniques come under this category:

a. Brovey Method
b. Principal Component Analysis
c. HIS based Method

In Frequency domain technique, first of all the image is transformed to the frequency domain. In this, the Fourier transform is evaluated and then rests of the operations are applied to it. After then the inverse Fourier transform is applied to achieve the output image. The image enhancement is done to increase the quality of the image by making few modifications to its content. The modifications brightness, contrast, distribution of the grey level etc are possible to perform [14].

2.1 Principal Component Analysis

PCA is conversion method which converts the number of associated variables into the format of set of unassociated variable. It works effectively and efficiently in case of image compression and image classification. The conversion of associated variables is done with the help of mathematical calculations and functions. It leads to the concise and finest description of data set [19]. The function of PCA is implemented in the form of principal component. The first principal component examined much of the dissents in the available data as supple. The second principal component is encumbered within the subspace which is perpendicular to first component. Then the value of maximum variance is selected as a third component. The PCA is a alternative

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mechanism which can be used in place of HIS technique. The working of PCA is as follows:

(1) First step is to electrocute IR to the value of PAN and MS and also resample the MS.
(2) Conversion of MS bands into components such as PC1, PC2, and so on.
(3) Twin of histogram between PAN and PC1.
(4) Reconstitute the PC1 with PAN.
(5) Conversion of PAN to left principal components.

The working of the PCA technique is depicted in figure below.

2.2 Discrete Cosine Transform

The major characteristic of Discrete Cosine Transform is that it facilitates the good signal approximation on the basis of coefficient values. This technique is used by many algorithms for transforming the image and as well as for watermarking also. The main advantage of this technique is that it has fast processing speed in contrast to other techniques. This is the easy and lossless compression mechanism.

It decomposes the image into two parts such as spectral sub parts. The working of this technique is quite similar of DFT i.e. Discrete Fourier Transformation since it also converts the image to frequency domain from spatial domain.

[3].

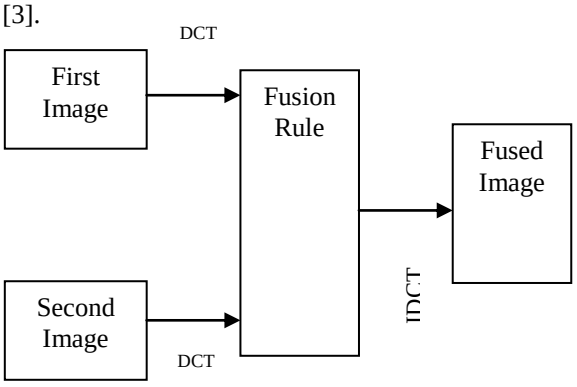

Figure1 Image Fusion with DCT [10]

2.3 Discrete Wavelet Transform

Discrete wavelet technique is used to transform the discrete signals into discrete wavelet representation. In this technique, an image is decomposed into coefficients and then this coefficient compares with the threshold. Value zero will be assigned to those whose coefficient value is less than threshold and the coefficient above the threshold value are encoded with the loss less compression technique. DWT involves decompose, threshold detail coefficients and then reconstruct. Generalize steps for the implementation of DWT is as below:

Step 1: Create a wavelet lower decomposition by applying the DWT mechanism.
Step 2: Apply fusion methods to each decomposition level.
Step 3: Apply Inverse DWT for achieving the original image.

The figure below shows that how the image is decomposed in DWT mechanism. First of all, the image is decomposed into right and left sub-bands. Then these sub-bands are further divided into upper and lower regions.

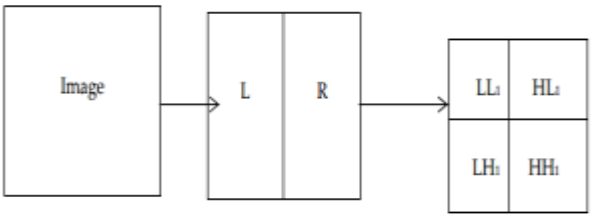

Figure 2 Discrete Wavelet Transform **[10][11]**

2.4 Stationery Wavelet Transformation

The SWT is a Stationery Wavelet Transformation technique which is developed to overcome the weaknesses of Discrete Wavelet Transformation technique. The problem found in DWT was lack of translation Invariance the solution of this is to remove or vanish the down samplers and up samplers in DWT. And perform the up sampling on filter coefficients in the j^{th} level of algorithm by applying the following equation:

$$2^{(j-1)} \qquad (1)$$

It is an a redundant technique because the number in the each level of output is similar to the number in corresponding input which leads to the N number of redundancy corresponding to the N number wavelet coefficients. The other name of SWT is "Algorithm of Trous". This name is derived from French a term which refers to the insertion of zeros at filters. The meaning of "Trous" in English is holes. It was developed by holschneider and also named as undecimated wavelet transform or algorithm of trous. It is an enhanced or modified version of DWT which does not destroy coefficient at every transformation level.

2.5 Laplacian Pyramid

It works on the basis of pyramid structure. This structure contains the elements like blocks which are related to the various levels of the real image. The fragmentation of an image into various levels is done by implementing low pass filters which recursively filters the low level image. As the level moves upward the image become minor by preceding the length of the image.

III. BACKGROUND

Phamila and Amutha [1] in their paper shown that multi focus image scheme which was based upon the higher highly values alternating coefficients abbreviated as AC coupled together with Discrete Cosine Transform concluded as an unproblematic as well as efficient plan in terms of pertaining cellular image sensor devices. These devices were built with the help of learning resource limited and battery pack driven graphic receptors. Moreover, the utilization of these devices was in the area of security and high risk atmosphere such as battlefields. The simulation analysis has performed using the proposed AC-DCT method

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which concluded that it has overcome the limitation of power of low power devices along with efficient actual calculation.

Li and Dong [2] discussed image fusion techniques applied on pixel level. In these fusion techniques, the particular processing along with synergistic combination of information was performed. The information i.e. combined was collected from the source images which focused on improving the perception of a scene. With the development of sensors, demand for correct combination of all available image datasets in a significant and spatial manner has been arisen. The image fusion techniques based on pixel level is applicable to several areas such as space borne remote sensing, machine vision and airborne.

The work performed by Sharmila et al. in the year of 2013 has shown that multimodality medial image fusion using the wavelet transformation and entropy produced better quality results in terms of quality information and less noise in the produced image. In the medial image fusion, the primary data can be derived simply using incorporating multimodality medical images such as Computed Tomography, Positron Emission Tomography, Magnetic Resonance Imaging and single Photon Emission Computed Tomography into a single image. This derived information can be used for several reasons including detection of tumor, diagnoses of diseases, surgery treatment etc. On the counterpart, Single modality image is not capable enough in providing useful information.

Anju Rani implemented image enhancement using image fusion technique in [4]. Image enhancement is a process which makes an image more meaningful and informative. In this work image fusion was used for enhancing the image quality. As the result of image enhancement the generated output image can be used for various purposes in near future by human being as well as machine. This paper provided a summarized review of various image enhancement techniques which were combined with image fusion techniques. A comparison between different image processing techniques was also explained by author.

Vadher Jagruti [5] in 2014 defined that with the advancement in the technology the working process of each and every area has been enhanced to automatic system from mannual systems. Hence various fields use the multisensor data. Due to which the need of image fusion arises. The image fusion is used for combining two or more images to generate a single meaningful image. This study provided a new hybrid technique for multi sensor image fusion by combining two prominent techniques i.e. DCT and Variance. Traditionally DWT was used for image fusion because it is simple and less complex to execute. The DWT is a robust and a flxible technique since it supports simple transformation amid cupious multi scale transform. It is quite analogous to wavelet based image fusion techniques. The comparison was done on the basis of hybrid DWT method for image fusion.

In 2014, C. Morris [6] explained that the image fusion is a process in which a set of images is collaborated as a single image. The purpose of image fusion is to make an image more enhanced and informative. The need of image fusion exist when there are too many images but all of them are not of good quality and less informative. Thus in such case the informative part of each image is combined to a single image so that the output or fused image can become more informative or meaningful. Various types of techniques are used for image fusion. The objective of this is to enhance the performance of image fusion technique by introducig the selective Minimum/Maximum and PCA specifically for spatial domain based images. the results show that the proposed spatial domain based technique is better than the traditional spatial domain based transformation techniques.

Rohan Ashok Mandhare(2013), [7] remote sensing is a technology which is used to capture the image of earth by using satellites. Image capturing in remote sensing is done by using multiple sensors. The images taken by the remote sensing technology is prone to impulse noise. Hence there are many techniques which can be used for removing the noise from the images and named as image filtering techniques.The objective of this research work was to implement pixel level image fusion based on mathematical and wavelet based transformation method for image fusion. The improvement in the capacity of spectral and spatial information was also evaluated. Various methods were used for practical implementation and the objectives was achieved by using various methods such as average method, wavelet based transformatuion, multiplicative method and brovey method. The performance evaluation was done by using various performance parameters suh as PSNR, entropy, standard deviation and RMSE. The results depicted that the multiplicative method and wavelet based method achieves high efficiency in compaison to other methods. The fused image generated by these methods also has higher spectral efficiency.

In the year of 2013, Liu et al. [8] unveiled that lifting schemes can be implemented to the multi focus image fusion for achieving the substantial information in final image. This technique processed in a high speed and consumes less storage. Thus these features make it more preferable over rest of the techniques. This method divided the input images into four sections which is known as sub bands i.e. LL, HL, HH and diagonal. These bands were comprised of frequency information of the image. Gaussian Kernel was implemented for ascertaining the weighted area energy. After observing the highest energy level between two images, it generated a binary map. Then sub band synthesizing was performed to obtain the final output image.

IV. CONCLUSION AND FUTURE SCOPE

Image fusion is implemented with an objective to integrate two distorted image with a purpose to achieve a single but meaningful image. The fusion is done to enhance the quality of an image. It is done by implementing different fusion techniques such as PCA, SWT, DWT, DCT etc. After having a review to the previous work it is concluded that it is required to optimize the fused results by applying various optimization techniques.

V. REFERENCES

[1] Y. Asnath Victy Phamila and R. Amutha. "Discrete Cosine Transform based fusion of multi-focus images for visual sensor networks." Signal Processing 95 (2014).

[2] Mingjing Li and Yubing Dong. "Review on technology of pixel-level image fusion." In International Conference on Measurement, Information and Control (ICMIC),vol. 1, IEEE, 2013.

[3] K Sharmila, S Rajkumar, V Vijayarajan. "Hybrid method for Multimodality Medical image fusion using Discrete Wavelet Transform and Entropy concepts with Quantitative Analysis." In International conference on Communication and Signal Processing (ICCSP), IEEE, April 3-5, 2013.

[4] Anju Rani et al (Sep 2014), "Image Enhancement using Image Fusion Techniques", IJARCSSE, Vol. 4, No. 9, Pp. 413-416

[5] Vadher Jagruti (2014),"Implementation of Discrete Wavelet Transform Based Image" Fusion. Journal of Electronics and Communication Engineering ,Volume 9, Issue 2, PP 107-109

[6] C. Morris(2014), "two stage spatial domain image fusion techniques", ICTACT journal on image and video processing, volume: 05, issue: 01 , pp8895-898,

[7] Rohan Ashok Mandhare(2013), "2690 Pixel-Level Image Fusion using Brovey Transform and Wavelet Transform",International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (IJAREEIE), Vol. 2, Issue 6, pp2690-2695

[8] Qingping Li, Junping Du, Fuzhao Song, Chao Wang, Honggang Liu, Cheng Lu. "Region-based Multifocus Image Fusion Using the Local Spatial Frequency", In Control and Decision Conference (CCDC), 25th Chinese, IEEE, 2013.

[9] L Ganesh, S P Krishna Chaitanya, J Durga Rao and M N V S S Kumar. "Development of Image Fusion Algorithm for Impulse Noise Removal in Digital Images using the quality Assessment in Spatial Domain" In International Journal of Engineering Research and Applications (IJERA) Vol. 1, Issue 3, 2007.

[10] Lixin Liu, Hongyu Bian and Guofeng Shao. "An Effective Wavelet-based Scheme for Multi-focus Image Fusion" In IEEE International Conference on Mechatronics and Automation (ICMA), 2013.

[11] Jasmeet kaur and Er. Rajdavinder Singh Boparai. "An evaluation on different image fusion techniques" IPASJ International Journal of Computer Science (IIJCS) Volume 2, Issue 4, April 2014.

[12] Huaxun Zhang and Xu Cao. "A way of image fusion based on wavelet transform" In 9th International Conference on Mobile Ad-hoc and Sensor Networks, IEEE, 2013.

[13] Gazal Malhotra and Dr. Vinay Chopra. "Improved multi-focus image fusion using ac-dct, edge preserving smoothing & DRSHE" In Proceedings of International Conference on Computer Science, Cloud Computing and Applications July 24-25, 2014.

[14] Sweta k. Shah and Prof. D.U. Shah, "A Review on Image Fusion Techniques", International Journal Of Innovative Research In Electrical, Electronics, Instrumentation And Control Engineering, Vol. 2, No. 3, Pp. 1258-1261, March 2014

[15] Shalima and Dr. Rajinder Virk, "Review Of Image Fusion Techniques", International Research Journal of Engineering and Technology, Vol. 2, No. 3, Pp. 333-339, June 2015

[16] Er.Kulvir Singh and Er.Neeraj Julka, "A Review on Image Fusion Techniques and Proposal of New Hybrid Technique", International Research Journal of Engineering and Technology, Vol. 3, No. 3, Pp. 1321-1324, March 2016

[17] Deepak Kumar Sahu and M.P.Parsai, "Different Image Fusion Techniques –A Critical Review", International Journal of Modern Engineering Research, Vol. 2, No. 5, Pp. 4298-4301, October 2012

[18] Suruchi Goyal and Rupinder Wahla, "A Review on Image Fusion", International Journal of Innovative Research in Computer and Communication Engineering, Vol. 3, No. 8, Pp. 7582-7588, August 2015

[19] Dhirendra Mishra and Bhakti Palkar, "Image Fusion Techniques: A Review", International Journal of Computer Applications, Vol. 130, No. 9, Pp. 7-13, November 2015